Announcements

□ Homework for tomorrow...

(Ch. 26, CQ 12, Probs. 16, 18, & 22)

CQ3:
$$E_3 = E_4 > E_2 > E_1$$

26.8: See handout
26.36: $E = \frac{1}{4\pi\epsilon_0} \frac{4\lambda y}{(y^2 + (d/2)^2)}$

□ Office hours...

MW 10-11 am TR 9-10 am F 12-1 pm

■ Tutorial Learning Center (TLC) hours:

MTWR 8-6 pm F 8-11 am, 2-5 pm Su 1-5 pm

Chapter 26

The Electric Field

(The Parallel-Plate Capacitor & Motion of a charged particle in an E-field)

Last time...

 \blacksquare *E*-field of a *ring* of radius *R* & charge *Q* on the *z*-axis..

$$E_{ring} = \frac{1}{4\pi\epsilon_0} \frac{Qz}{(z^2 + R^2)^{3/2}}$$

 \blacksquare *E*-field of a *disk* of radius *R* & charge *Q* on the *z*-axis..

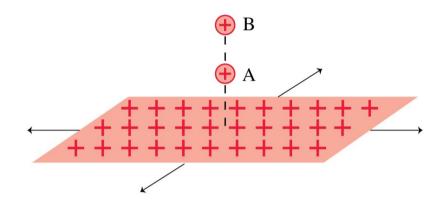
$$E_{disk} = \frac{\eta}{2\epsilon_0} \left[1 - \frac{z}{\sqrt{z^2 + R^2}} \right]$$

□ *E*-field of an *infinite plane*...

$$E_{plane} = \frac{\eta}{2\epsilon_0}$$

Quiz Question 1

Two protons, A and B, are next to an infinite plane of positive charge. Proton B is *twice* as far from the plane as proton A. Which proton has the larger acceleration?



- 1. Proton A.
- $\underline{\mathbf{proton}}$ Proton B.
- 3. Both protons have the same acceleration.

Quiz Question 2

At the dot, the *y*-component of the *E*-field due to the shaded region of charge is

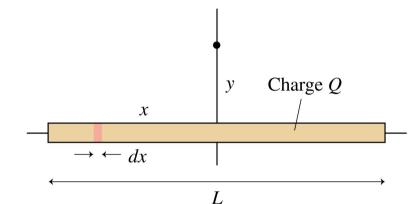
1.
$$\frac{(Q/L) dx}{4\pi\epsilon_0(x^2+y^2)} \times \frac{y}{x}$$

$$\frac{(Q/L) dx}{4\pi\epsilon_0(x^2+y^2)} \times \frac{x}{y}$$

3.
$$\frac{(Q/L) dx}{4\pi\epsilon_0(x^2+y^2)} \times \frac{x}{\sqrt{x^2+y^2}}$$

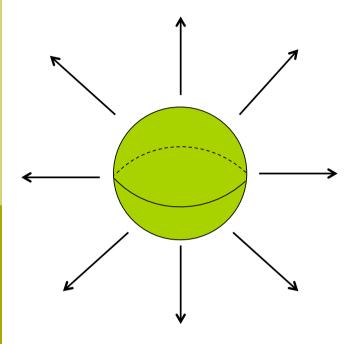
4.
$$\frac{(Q/L) dx}{4\pi\epsilon_0(x^2+y^2)} \times \frac{y}{\sqrt{x^2+y^2}}$$

$$\frac{(Q/L) dx}{4\pi\epsilon_0 \sqrt{x^2 + y^2}} \times \frac{y}{\sqrt{x^2 + y^2}}$$



E-field of a sphere..

A sphere of charge *Q* and radius *R* (uniformly charged or a spherical shell) has an *E*-field of the form...

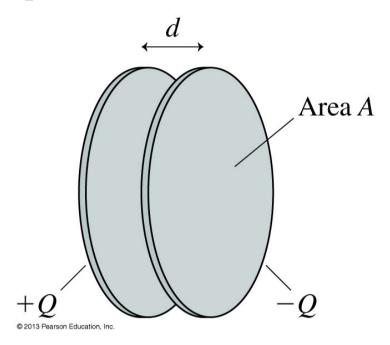


$$E_{sphere} = \frac{1}{4\pi\epsilon_0} \frac{Q}{r^2} \text{ for } r \ge R$$

■ *Exactly* the same as that of a point charge!

26.5: The Parallel-Plate Capacitor

Two electrodes, one with charge +Q and the other with -Q, placed face-to-face a distance d apart..



The Parallel-Plate Capacitor

 $lue{}$ What's the *E*-field *between* the plates?

 $lue{}$ What's the *E*-field *outside* of the plates?

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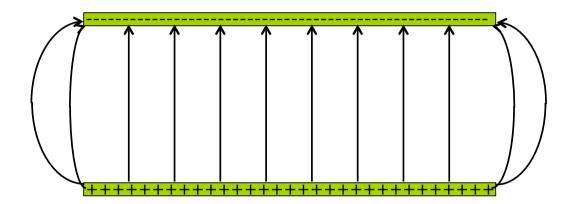
The Parallel-Plate Capacitor

 \Box What's the *E*-field *between* the plates?

$$\vec{E}_{capacitor} = \frac{\eta}{\epsilon_0}$$
, from + to -

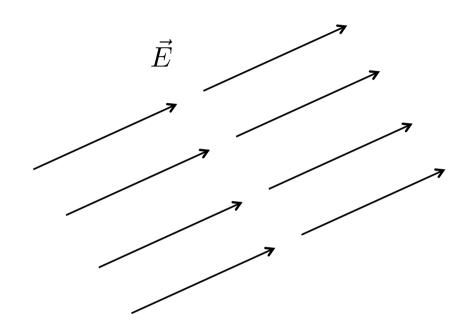
 $lue{}$ What's the *E*-field *outside* of the plates?

$$\vec{E}_{capacitor} = \vec{0}$$



Uniform E-Field...

- □ is the *same* in *magnitude* and *direction* at every point in space.
- □ Parallel-plate capacitors produce *uniform E*-fields



26.6:

Motion of a Charged Particle in an *E*-Field

□ The *E*-field exerts a force on a charged particle...

$$\vec{F}_{onq} = q\vec{E}$$

 \square If it's the *only* force acting on q, then...

$$\vec{F}_{net} = q\vec{E} = m\vec{a}$$

□ If it's a uniform *E*-field, then...

$$a = \frac{qE}{m} = \text{constant}$$

i.e. 26.8:

An e⁻ moving across a capacitor

Two 6.0 cm diameter electrodes are spaced 5.0 mm apart. They are charged by transferring 1.0 x 10^{11} e^- s from one electrode to the other. An e^- is released from rest at the surface of the negative electrode.

How long does it take the e^- to cross to the positive electrode? What is its speed as it collides with the positive electrode? Assume the space between the electrodes is vacuum.